

EFFECTS OF HYDROLOGICAL CHANGES ON THE BIODIVERSITY AT KEOLADEO NATIONAL PARK AND THEIR IMPACT ON ECOTOURISM

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ABSTRACT

Rajasthan is playing a vital role in the Indian tourist scene as out of 1.8 million tourists visiting India every year and the state attracts about 30% of the foreign tourists. Keoladeo National Park (KNP) is one of very well known world heritage site (since 1985) and bird sanctuary (since 1956) in Rajasthan state of India. KNP have been the attraction for tourists for long time. Presently the image of this world heritage is adversely affecting due to decreasing number/variety of arriving birds which is ultimately affecting the ecotourism system in KNP. Hence, a study is being carried out on hydrological changes and their effect on ecotourism which is presented in this paper. Presently, the natural water supply resources in the KNP have disturbed (e.g. construction of Panchana dam on Gambhiri River) due to which the wetland of KNP is suffering from improper water supply. As water supply supplements in KNP, Chambal pipe line and Goverdhan project have been developed but still they are not satisfying the needs of KNP ecology. Thereby lowering in the number of migratory species in KNP was examined in last 4years. Formerly, domestic as well as the foreign tourists used to visit KNP for 3-7 days but now-a-days spending commonly 2-4 hours due to loss of suitable habitat. 50% of tourist preferred to visit park in winter months to see numerous migratory birds. Shorter stay of tourist in KNP is ultimately reducing survival of local community of Bharatpur such as rickshaw pullers and hotels.

KEYWORDS: Keoladeo National Park; Water Resources, Hydrological changes; Ecotourism

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INTRODUCTION

The key environmental forcing factor in wetlands is hydrology. Hydrology condition of particular wetland extremely defined its structure and function. Hydrologic condition and its fulfilment affect many abiotic properties in soil behaviour, salinity and nutrient availability in coastal wetland [1]. Timely assessment and its implications in future changes made in hydrological variable can minimize their adverse impact on system (wetland). Most wetlands in the tropics are subjected to considerable water-level fluctuations according to the dry and rainy season and it belongs to the floodplain category [2]. Inconsistency of water in wetlands is attributed to changes in hydrologic outputs and inputs and linked to hydraulic controls [3]. Change in water level is significant factor for many aquatic fauna and flora [4-5]

Plant and the animal communities existence particularly birds arrival and departure are affected by the physical characteristics of the environment [6-9] in a wetland ecosystem dependent on the seasons and hydrology

[10]. Migratory birds experience increasingly severe food shortages on their wintering grounds due to reduced rainfall, this could affect non-breeding performance and influence their time of departure for their breeding grounds [11].

In the present study the hydrological changes in the wetland of KNP, Bharatpur ($27^{\circ}07' - 27^{\circ}12'N$, $77^{\circ}29' - 77^{\circ}33'E$) is situated on National Highway 11 Agra –Jaipur, 50 km west of Agra) has been studied. The KNP is facing problem due to the reduction of bird species and its population due to these hydrological changes and subsequently affecting tourist pattern in KNP. Unlike many other protected sites, the KNP have been given overweigh to nature tourism. Being a world heritage site, the KNP has been well know as centre for attraction for nature loving domestic as well as foreign tourists. Conservation of protected area is important function and recreational opportunities in a natural situation is main entity provided by these protected areas [12-14]. Hence, for a sustainable tourism development, a proper balance in ecological structure and ecotourism in these areas [15] is needed. Accordingly a study is being presented in the article.

STUDY AREA AND METHODOLOGY

Bharatpur is famous tourism city in eastern part of Rajasthan due to Keoladeo National Park. on golden triangle of Delhi-Agra-Jaipur as shown in Figure 1. The total area of the park is 29.56 square km. It was designated a Wetland of International Importance in 1977, under the terms of the Ramsar Convention on Wetlands. Due to its exceptional nature of variety of vegetation Marshes, Shrubs, trees and Savanah congregations of migratory waterfowl Siberian crane, ducks and pelicans can be seen. It is considered a major bird sanctuary and was recognised as a World Heritage Site in 1981.

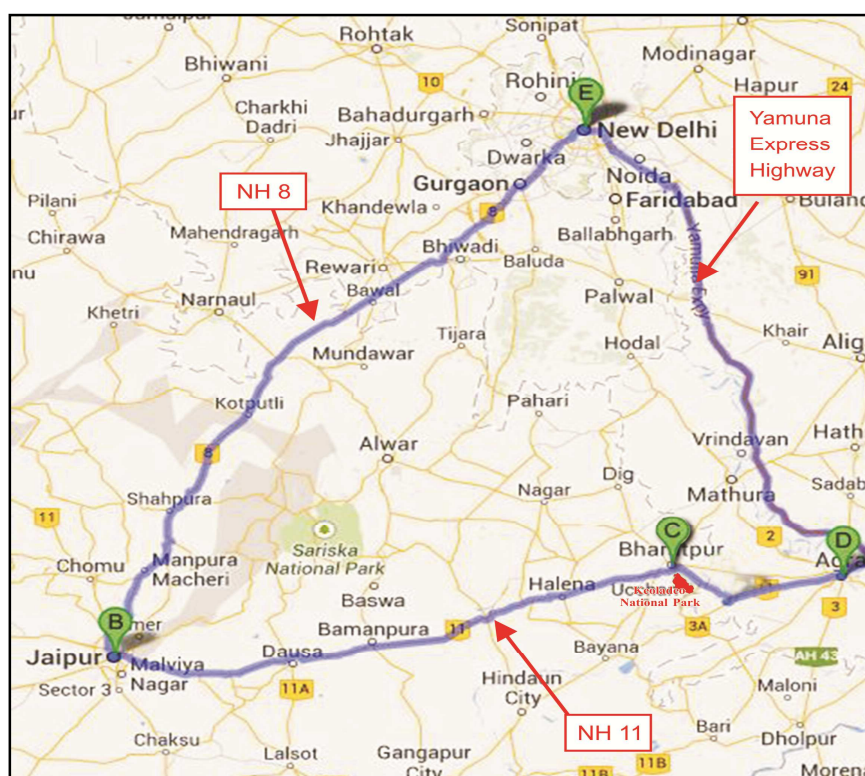


Figure 1: Ecotourism Destination KNP Bharatpur Lying On NH-11 on Golden Triangle Delhi-Agra-Jaipur

It attracts a growing number of avifauna to this wetland every year. There is a climate of hot summers and freezing winter cold. June temperatures average between $25^{\circ}C$ and $30^{\circ}C$ but can rise in day time to above $47^{\circ}C$. In the winter months temperatures can drop to $0^{\circ}C$. Winter humidity is over 85%, compared with 54% in summer. The monsoon

is the main source of precipitation, with the major rainfall occurring in July, August and September. Mean annual rainfall is 664mm.

The KNP has been surveyed and studied at monthly intervals starting from July 2011 to March 2014. An initial checklist of the vegetation and birds was prepared following random trips to the park before commencing the systematic study. Secondary data were collected from local departments. Water samples were taken from predetermined point and tested. The depth of the park at various blocks were calculated using coloured markings made along the embankments and along stakes randomly erected in the middle of the blocks. Extensive survey of visitors and local dependent community was made regularly on basis of questionnaire prepared.

RESULTS AND DISCUSSIONS

Hydrological Changes

Bharatpur flood plains were regularly flooded by waters from Banganga and occasionally also from Ruparail and Gambhiri as shown in Figure 2 (a). The marshes of Bharatpur performed important function of storing flood waters. They used to release the water slowly towards east and of recharging groundwater, to provide potable drinking water for people of this region and also for irrigation. Water from various sources was gradually ceased due to dammed at various places in Banganga and Ruparail rivers and construction of Panchana dam on Gambhiri River shown in Figure 2 (b).

Total requirement of water application in KNP was estimated to 500 mcft. Earlier this requirement was fulfilled both by rainfall as well as from water inputs from river Gambhiri through Ajan earthen dam shown in Figure 3. Panchana Dam has been constructed and completed in 2003 near Karauli town which is about 90 kms upstream from KNP on river Gambhiri. Thereafter water stress has been started in KNP. These all hampered the ecosystem of KNP which completely destroyed flora and fauna in 2005 and 2007. UNESCO threatened to taken back its world heritage value not maintaining its ecological value then State Government had taken emergent steps to explore other viable sources to supply water in KNP. Chambal pipe line project, Goverdhan Drain Chiksana canal were some suitable options for immediate relief providing water emergency. Water from alternatives sources were supplied depending upon availability as shown in Table 1. The data indicates that the same sources were not used simultaneously.

Quantum of water supplied from various sources was continuously changing. Minimum 63 and 81 mcft water from Goverdhan and Chambal project in 2014, 2013 respectively whereas maximum 297 and 335 mcft amount of water from Chambal Project had been supplied in 2011 and 2012 respectively. A change in timing of supply of water inputs and water quality in KNP causes changes in water parameters such as depth, solute concentration, in turn also affect food availability, sizes of fauna and flora species. This influence directly or indirectly bird congregation. Major aquatic blocks namely K, L, D and E in KNP attract migratory birds and play crucial role in ecology. Their corresponding area and average water depth during study has been shown in Table 2.

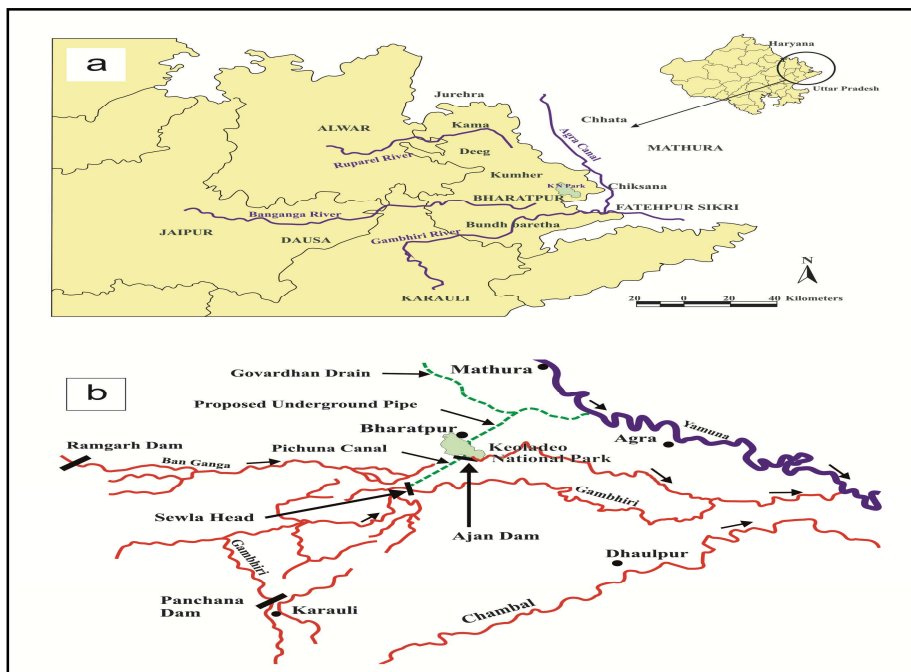


Figure 2 (A): The Main Water Sources Ghambhira and Banganga River Governs Water Application in KNP Bharatpur and (B) Water Application in KNP from Ghambhira and Banganga Rivers Drainage Route Seized Due to Construction of Series of Dams and Head Works

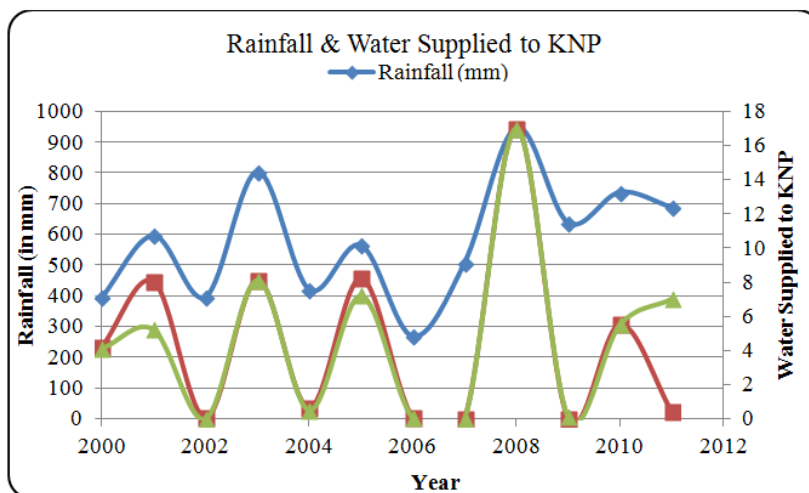


Figure 3: Variation of amount of Water Received in Ajan Dam and Water Supplied in KNP during 2000-2012 with Rainfall

Table 1: Water Supplemented from Various Alternative Sources to KNP

Year	Input Water Release to Keoladeo National Park(Mcft)				Total water supplemented in KNP (mcft)
	Panchanadam to Ajan Earthen Dam	Chambal Pipe Line Project	Time of Supply	Goverdh an Canal	
2010	195	Nil	-	Nil	195
2011	Nil	297	10 Oct11Feb12	Nil	297
2012	234	335	16Jun12-31Mar13	Nil	596
2013	126	81	26June-20Sep13	186	393
2014	Nil	201	22Jul14-5Jan15	63	264

Table 2: Aquatic Block, Their Area and Water Depth in KNP

Aquatic Block	Area (Sq. Km)	Perimeter (In Km)	Containing Average Depth of Water (Metre)
D	1.39	4.8	1.20
E	1.56	5.4	1.35
K	2.28	5.9	1.15
L1	3.06	7.6	1.20
L2	1.45	5.9	1.25

Open Water of Ajan dam contains nutrients and carrying fish persist high biological content essential for vegetation growth and preferred for birds activities. As Chambal project water conveyed in enclosed glass reinforced pipeline and pre-treated water supplied in Bharatpur for drinking purpose hence not containing biological parameter. But supplementation of Chambal water pursuing the requirement of KNP for maintaining aquatic area particularly in L and K blocks. Water supplement by Goverdhan drain having low biological values as carrying low amount of fish which were not sufficient for nourishment for various resident and migratory birds in KNP but this supplementation has been proved useful for preserving KNP ecology.

Effect of Hydrological Changes on Biodiversity of KNP

Biodiversity of Keoladeo National Park's flora was amazing as 375 species of angiosperms of which 90 species were wetland species, had been seen [16]. The fauna includes 350 species of birds (migratory and resident). Twenty seven species of mammals and fifty eight species of fishes inhabit the park. Biodiversity is essential to human well-being and survival by regulating climate and maintaining ecosystem resilience. Many wetlands in eastern Asia and northern Australia have been degraded and under increasing pressure from the introduction of *alien species*, *water pollution*, *urban encroachment*, *reclamation and infilling*, and *hydrological disruption* [17-20]. A considerable change has been also experienced in KNP due to uneven and irregular water supply. After 2010, changed water sources in KNP and its quality affected the habitats due to non availability of nutrients and adequate food. Consequently KNP wetland exhibited significant changes in resident, migratory bird population.

KNP was the only known wintering ground, famous globally for the central population of the *Siberian Cranes*. It has been observed that population of Siberian crane reduced very sharply which were 100 in 1970, was two in 2002 and completely absent after 2004 as shown in Figure 4.

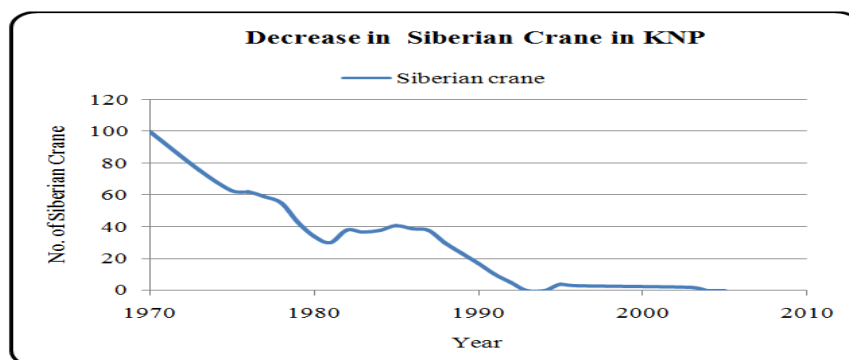


Figure 4: Swift Decrease in Siberian Crane Population in Keoladeo National Park

Now Siberian Crane is critically endangered species not only in KNP but also on Central Asian Flyway routes. Other renowned Migratory aquatic birds that arrived in KNP in large numbers are Graylag Goose, Bar-headed Goose,

Comb Duck, Ruddy Shelduck (Anatidae) and Purple Swamphen, Eurasian Moorhen (Rallidae), Black-Ibis, Red crested Pochard, White eyed Pochard, Mallard, Cotton pygmy goose etc. The population trends for some these birds from 2008 to 2015 are tabulated in the Table 3 which is showing that these species in KNP are vanishing.

**Table 3: Changes in Migratory Bird Population in KNP Bharatpur
Showing Tendency to Vanishing Species for KNP**

Species	Black-Ibis	Red Crested Pochard	White Eyed Pochard	Mallard	Cotton Pygmy Goose
2008-09	10	0	0	2	24
2009-10	0	0	0	0	0
2010-11	0	0	0	0	0
2011-12	0	0	0	0	0
2012-13	0	0	0	0	0
2013-14	2	2	0	0	0
2014-15	3	4	0	0	0

As clear from Table 3, the overall number of migratory birds has decreased in KNP since 2008 to 2015. Black-Ibis and Cotton pygmy goose reduced swiftly 10 to 2 and 24 to 0 respectively whereas Red crested Pochard increased 0 to 4. White eyed Pochard, Mallard and Cotton pygmy goose are among those, vanishing from KNP in last 5 years. In a nutshell it is resulted out that from last decade the number and variety of migratory birds used to come in KNP has been decreasing continuously due to deprived ecology which is very serious concern for the image of KNP. The hydrological changes in KNP might be the reason for this loss in KNP.

Impact on Ecotourism at KNP

There are many ways to categorise tourists visiting Keoladeo National Park. Visitors mainly divided into two category mainly foreigners and domestic visitors. Domestic visitors are subdivided in adults and students. This site is famous as National park and world heritage site so large numbers of students and visitors in groups visit during vacation and winter holidays as monthly variation of foreign tourist shown in Figure 5. The park is divided into tourist zone and bird watching zone for tourism. Maximum facilities such as Salim Ali centre and aquatic area are located in the tourism zone and are accessible by road. The bird watching zone is relatively undeveloped, apart from the provision of a few trails which are also used for patrolling the more remote regions and to see mammals and birds by photographers and bird watchers only.

Tourism to Keoladeo National Park is highly seasonal and degree of variation is again distinct noticeable between categories of visitor as foreigner and domestic visitors. KNP was dominantly crowded by domestic visitors during the Christmas and New Year vacations. The trend for number of visitors in KNP is shown in Figure 6. The numbers of domestic tourists are much more than foreigners. The ratio of domestic to foreign tourist was 3:1 to 4:1 in last 5 year in favour of domestic tourism. Foreign tourist inflow in KNP decreased from 2005 to 2014 during peak season November to January. This was due to lowering of richness of migratory bird in KNP and shifted to other nearby wetlands.

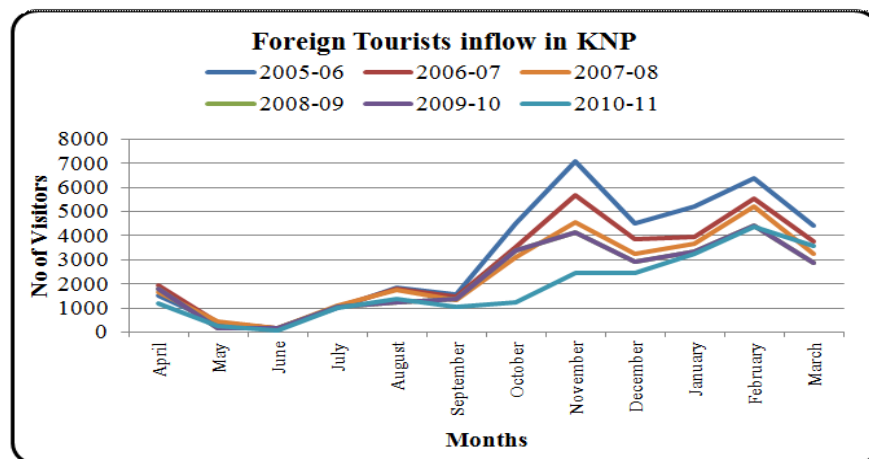


Figure 5: Monthly Flows of Foreigner Tourist in KNP Shows Maximum Visitors are Concentrated in Winter Depending Richness and Heronry in Related Year

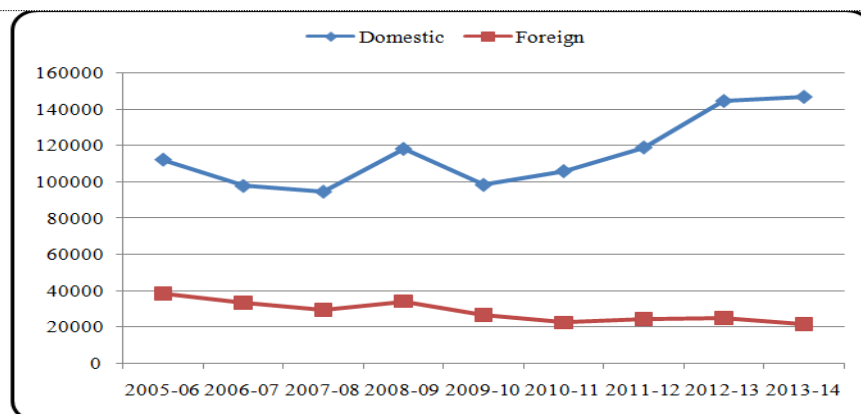


Figure 6: The Trend for Number Foreign and Domestic Visitors in KNP

Percentage monthly inflow of total tourist and foreign tourist in KNP was shown in Figure 7. Maximum numbers of monthly inflow of foreign tourist is in November (18%) as KNP is full of breeding birds with their cheeks and migratory birds can be seen. Whereas maximum numbers for total tourist was observed in December and January (21 % and 18% respectively) because the domestic visitor prefers to visit during winter vacation.

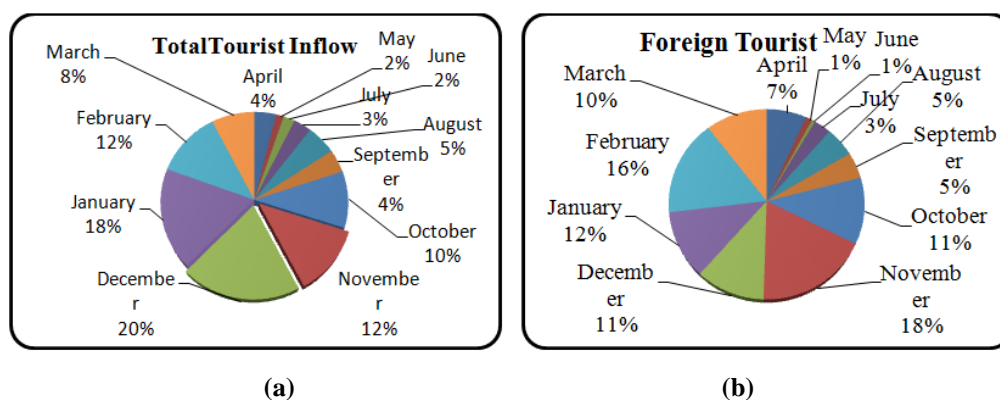


Figure 7: Percentage Monthly Inflow of Total Tourist and Foreign Tourist in KNP

Based on sample survey through 936 tourists response it was found that over 75% of those who had visited the park had spent at least two and half hour at the site. Nearly 12% of visitors had spent at least half a day, and approximately

3%, at least a full day. Currently average amount of time spent in the park is a little over 3 hours. This was earlier over 5 hours and divided in morning and evening session thereby most of dependent community rickshaw puller, guide and hotel staff were earning appealing money.

As a result of the observations and studies it is found that the total time spent by the visitors is decreasing which is not good for future ecotourism of KNP, Bharatpur. The main earning of the hotels and local rickshaw workers are due to foreign visitors because they use to stay long time and use the hotels if they visited. On the other hand the domestic visitors generally hire vehicles from their own cities/towns and not use to stay in hotels. The number of foreign visitors is mainly adversely affecting due to the reducing number of breeding/migratory birds which is the result of adverse hydrological changes in the KNP. Recently management are planning to create deep water bodies and earth mounds are being constructed in the more remote areas of the park in order to control water weeds and provide more viewing areas. Management has recently put signs at sensitive points within the park, creating facilities for visitors and employing eco-friendly E-rickshaw. Such initiatives will attract more visitors in future and are important aspect of park management.

Besides the environmental factors, some social factors are also affecting the number of visitors in KNP. As an example, since 2005 onwards, during the local Gurjar movement for reservation, the people blocked NH 11 and railways routes many times which restricted the number of visitors.

So it is suggested that some measures should be taken at Government level to maintain the compatible and healthy ecology system for migratory birds due to which the KNP is having reputation at world map. It is also the social responsibility of local bodies, organisations and people to maintain the dignity of this world heritage by avoiding the activities which are annoying to the foreign visitors.

CONCLUSIONS

Ecotourism is currently the only way permitted to make efficient use of Keoladeo National Park. Insufficient supply of timely and proper water is changing the hydrology of KNP wetland which is not healthy for birds. These hydrological changes are badly affecting the park's ecosystem and subsequently the number of visitors. Reducing number of foreign visitors is adversely affecting the earning of local dependent community and hotels around KNP. Tourism can be encouraged by maintaining suitable habitat with proper and timely supply of water to the park and related facilities at the site. Government is also taking various initiatives to regain the world level image of this Park.

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